2

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91164

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NZQA

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Level 2 Chemistry, 2017

91164 Demonstrate understanding of bonding, structure, properties and energy changes

2.00 p.m. Thursday 16 November 2017
Credits: Five

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of bonding, structure, properties and energy changes.	Demonstrate in-depth understanding of bonding, structure, properties and energy changes.	Demonstrate comprehensive understanding of bonding, structure, properties and energy changes.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

A periodic table is provided on the Resource Sheet L2–CHEMR.

If you need more room for any answer, use the extra space provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–12 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

Achievement

TOTAL 12

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exo
endo

QUESTION ONE

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(a) When solid calcium chloride, $CaCl_2(s)$, reacts with water, the temperature increases.

Circle the term that best describes this reaction.

endothermic **exothermic**

Give a reason for your choice.

Energy is released as the temprature increases

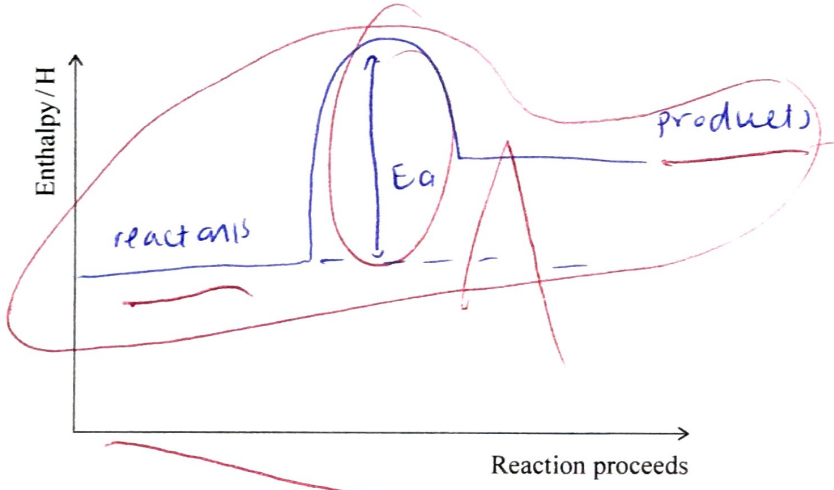
(b) When a person sweats, water is lost from the body by evaporation. This is an endothermic process. This evaporation speeds up when a person exercises.

(i) Explain why the evaporation of water in sweat from the body is endothermic, and why exercise increases this evaporation.

Evaporation of water in sweat from the body is an endothermic reaction as it involves bonds breaking, as liquid bonds are ~~formed~~ broken to form gas bonds instead for the sweat to evaporate

(ii) Draw a labelled enthalpy diagram for the evaporation of water, $H_2O(\ell)$.

$H_2O(\ell) \rightarrow H_2O(g)$ $\Delta_r H^\circ = 40.7$ kJ mol^{-1}



(iii) Sodium chloride, NaCl, is another compound that is excreted from the body in sweat.

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Use your knowledge of structure and bonding to explain the dissolving process of sodium chloride, NaCl, in water.

Support your answer with a labelled diagram.

NaCl is an ionic substance made up of Na^+ and Cl^- ions held together by ionic bonds in fixed position. NaCl Ionic solids are made out of oppositely charged particles held in fixed position in a 3D lattice. NaCl is an Ionic solid made up of Na^+ and Cl^- ions. NaCl is able to dissolve in water as water is a polar substance made out of H^+ and O^- ions. Therefore There the slightly negative side δ^- O^- will be able to attract the Na^+ ions out of the 3D structure and the slightly positive side of water δ^+ H^+ will be able to attract the Cl^- ion out of the structure, these forces are much stronger than the ionic forces that hold these particles together therefore is able to overcome it.

Space for diagram

(c) Thermite reactions occur when a metal oxide reacts with a metal powder.

The equations for two thermite reactions are given below:

Reaction 1: $Fe_2O_3(s) + 2Al(s) \rightarrow 2Fe(s) + Al_2O_3(s)$ $\Delta_r H^\circ = -852$ kJ mol^{-1}

Reaction 2: $3CuO(s) + 2Al(s) \rightarrow 3Cu(s) + Al_2O_3(s)$ $\Delta_r H^\circ = -1520$ kJ mol^{-1}

Use calculations to determine which metal oxide, iron(III) oxide, $Fe_2O_3(s)$, or copper(II) oxide, $CuO(s)$, will produce more heat energy when 50.0 g of each metal oxide is reacted with aluminium powder, $Al(s)$.

$M(Fe_2O_3) = 160$ g mol^{-1} $M(CuO) = 79.6$ g mol^{-1}

$n = \frac{m}{M}$

$n(Fe_2O_3) = \frac{50.0}{160}$

$n = 0.312$ mol

$n(CuO) = \frac{50.0}{79.6}$

$n = 0.629$ mol

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A4

QUESTION TWO

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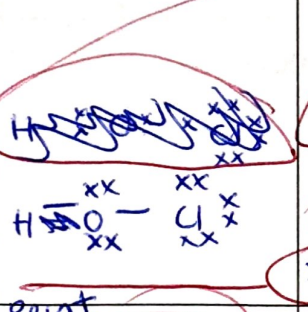
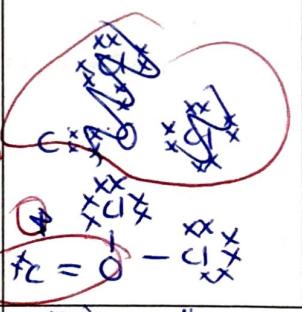
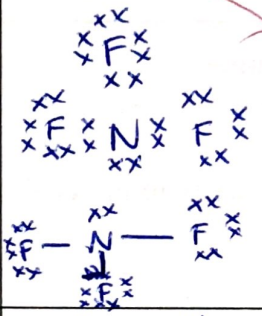
(a) (i) Draw the Lewis structure (electron dot diagram) for the following molecules, and name their shapes.

Molecule	HOCl	$COCl_2$	NF_3
Lewis structure			
Name of shape	Bent	Trigonal Planar	Trigonal Pyramid
Approximate bond angle around the central atom	109.5°	120°	109.5°

(ii) Justify the shapes and bond angles of HOCl and $COCl_2$.

HCOl has 4 reigons of negative charge around the central atom 'O'. All repelling as far as way as possible to minimize repulsion. 2 of these are involved in bonding with two non bonding pairs the bonded pairs resulting in a bent shape with angles of 109.5°. $COCl_2$ has 3 reigons of negative charge around the central atom O. All repelling, all of these pairs are involved in bonding. The bonded atoms resulting in a trigonal plana shape, with bond angles of 120°.

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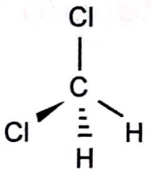
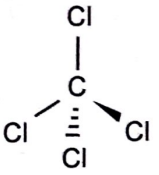
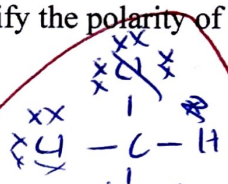
(b) Three-dimensional diagrams for two molecules are shown below.

Molecule		
Name	Dichloromethane	Tetrachloromethane
Polarity of molecule	polar	non polar.

(i) In the boxes above, identify the polarity of each molecule, by writing either **polar** or **non-polar.**

(ii) Justify your choices.



Dichloromethane has 4 reigons of negative charge around the central atom C. All repelling. All 4 of these are involved in bonding. The bonded pairs resulting in a tetrahedral shape with angles of 109.5° There is a difference in electronegativity around the molecule and there are polar bonds as Cl is more electronegative than C. These dipoles add giving an overall dipole therefore the molecule is assymetrical and polar. Tetrachloromethane has 4 reigons of negative charge around the central atom C. All repelling as far away as possible to minimise repulsion. There are polar bonds as Cl is more electronegative than C. However there is no difference in electronegativity around the outside of the molecule so the molecule is symmetrical and non polar.

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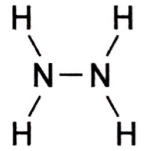
(c) Hydrazine, N_2H_4, is used as rocket fuel.

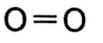
Use calculations to determine which of **Reaction 1** or **Reaction 2** releases more energy.

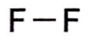
Reaction 1: $N_2H_4(g) + O_2(g) \rightarrow N_2(g) + 2H_2O(g)$

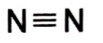
Reaction 2: $N_2H_4(g) + 2F_2(g) \rightarrow N_2(g) + 4HF(g)$

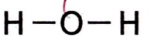
The structure of each chemical species is shown in the box below.

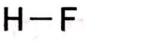

hydrazine


oxygen


fluorine


nitrogen


water

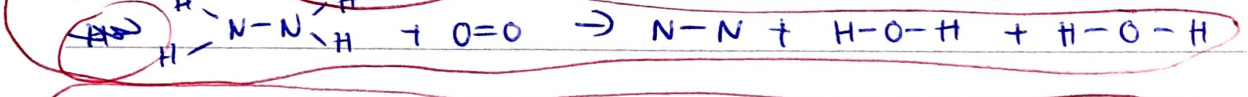

hydrogen fluoride

Use the average bond enthalpies given in the table below.

Bond	Average Bond enthalpy /kJ mol^{-1}	Bond	Average Bond enthalpy /kJ mol^{-1}
H–H	436	N–N	158
H–F	567	F–F	159
N–H	391	O=O	498
O–H	463	N≡N	945

Show your working and include appropriate units in your answer.

reaction 1

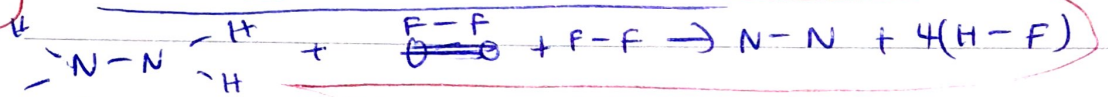


391 158 498 159 463 463

$4(H-N) + 1(N-N) + 1(O=O) \rightarrow 1(N-N) + 2(O-H) + 2(O-H)$

$1564 + 158 + 498 \rightarrow 2010$

$2220 \rightarrow 2010$ $\Delta h = +210 kJ\,mol^{-1}$



391 158 159

$4(H-N) + 1(N-N) + 2(F-F) \rightarrow 158 + (4 \times 567) =$

$1564 + 158 + 318 \rightarrow 158 + 2268$

$2040 \rightarrow 2426$

$2040 - 2426$ $\Delta h = -386 kJ\,mol^{-1}$

reaction 2 releases more energy

A4

QUESTION THREE

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(a) Complete the table below by stating the type of solid, the type of particle, and the type of bonding (attractive forces) between the particles in each solid.

Solid	Type of solid	Type of particle	Attractive forces between particles
Al(*s*) (aluminium)	metallic	atoms	metallic bonds
$MgCl_2$(*s*) (magnesium chloride)	Ionic	Ions	Ionic bonds
S_8(*s*) (sulfur)	molecular ~~molecules~~	molecules ~~bonds~~	weak intermolecular bonds

(b) Circle the substance which has the lowest melting point.

Al(*s*) $MgCl_2$(*s*) S_8(*s*)

Justify your choice, referring to the attractive forces between the ~~particles~~ of ALL three substances.

~~Aluminium is a metallic sub~~ The substance with the lowest melting point is Se (sulfur) This is because Aluminium is a metallic substance ~~which~~ held together by metallic bonds. In a 3D lattice surrounded by some free moving electrons ^ There ~~are~~ of bonds are difficult to overcome due to the non directional nature of its structure ~~these bonds~~, a bit of energy is needed to overcome and break these bonds. $MgCl_2$ is an Ionic substance made of Mg^{2+} and Cl^- ions held together in a 3D lattice they are held together by Ionic bonds and are very brittle and ~~brittle~~ compared to the strong metallic bonds in Aluminium Se has the lowest melting point. molecules are ~~held together~~ made of molecules held in a 3D lattice through weak intermolecular bonds. most often molecular substances are liquids or gases at

room temprature. ~~They have to~~ and are very soft and brittle. They have low melting points as only little energy is needed to overcome and break the weak inter molecular forces between the particles in the structure.

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Question Three continues on the following page.

(c) Circle the substance which is malleable.

Al(s) $MgCl_2(s)$ $S_8(s)$

Justify your choice by referring to the structure and bonding of your chosen substance.

You may include a diagram or diagrams in your answer.

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Aluminium is the substance which is malleable this is because Aluminium is a metalic substance made up of atoms in a 3D lattice held together by strong metallic bonds, surrended by some free moving valence electrons. Because the metallic structure with the substance It is malleable due to the non directional natre of its structre which enable the substance to be malleable aswell as ductile without breaking the its structre.

Space for diagram

A4

Extra paper if required.
Write the question number(s) if applicable.

QUESTION NUMBER

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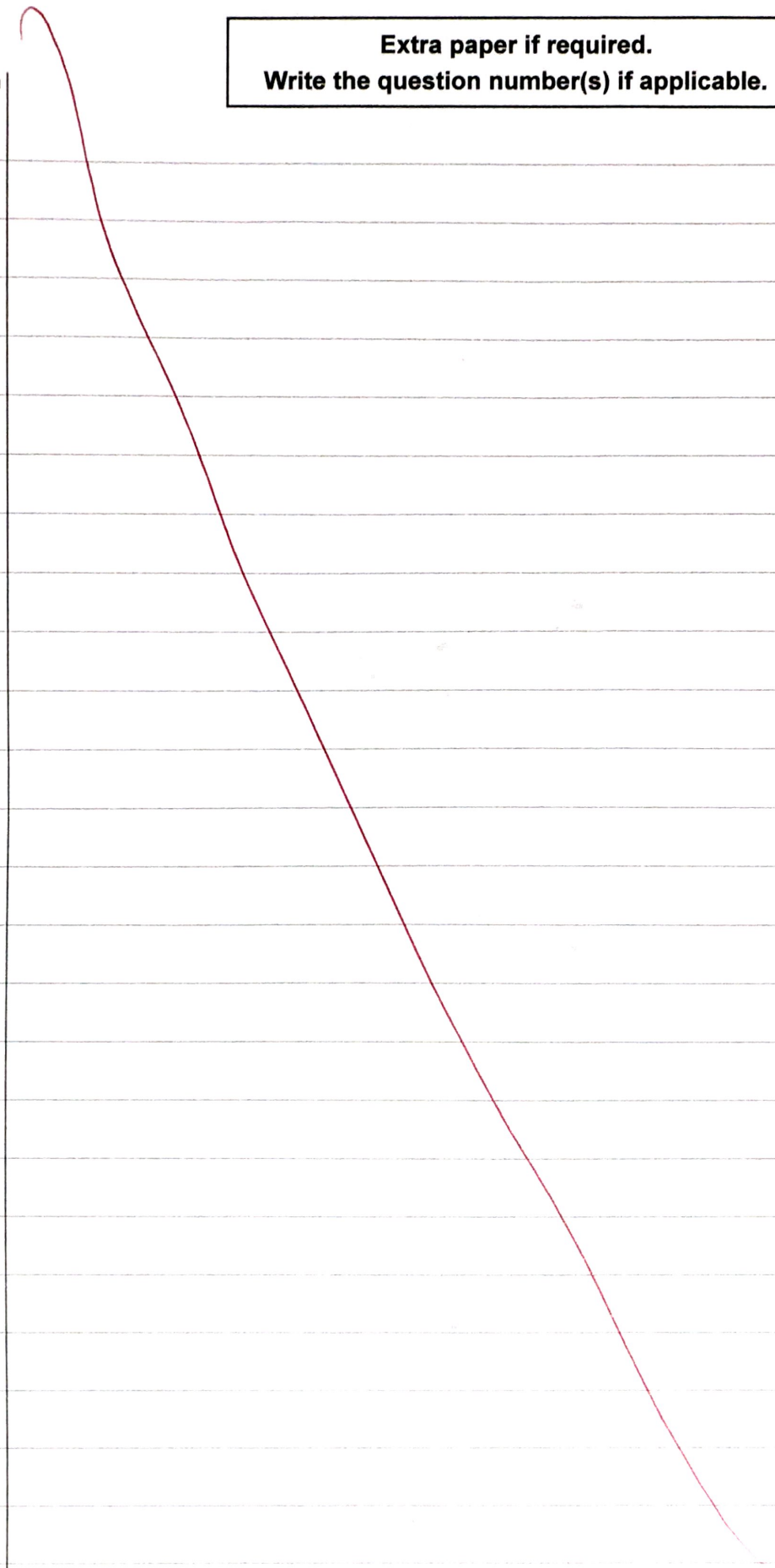

Subject:	Chemistry	Standard:	91164	Total score:	12

Q	Grade score	Annotation
1	A4	This candidate received a grade score of A4 as it identified an exothermic reaction as well as bond breaking during evaporation, the response further drew an enthalpy diagram, described water as polar and calculated amounts correctly.
2	A4	The grade score of A4 was given as it showed the correct drawing and labelling of Lewis structures, linking the central atom's regions of negative charge to bond angles, identifying molecular polarity and that there was a difference in electronegativity in molecules, as well as identifying most of the bonds broken and made in a chemical reaction.
3	A4	This received A4 for linking solid type, particle type and attractive forces, while also identifying the strength of both metallic bonds and intermolecular bonds, as well as the 3-D lattice nature of aluminium.